The influence of phase defect characteristics on scattered light images in actinic dark-field inspection

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Summary and conclusion

◆**Actinic dark-field image was captured with high magnification optics and a relationship between defect size and focus tendency was examined. Simulation was executed to understand a relationship between phase defect size and focus position tendency.**

◆**It was confirmed that defect width has a strong relationship with best focus position. On the other hand, defect height/depth has a weak relationship with best focus position. This tendency was also confirmed with simulation.**

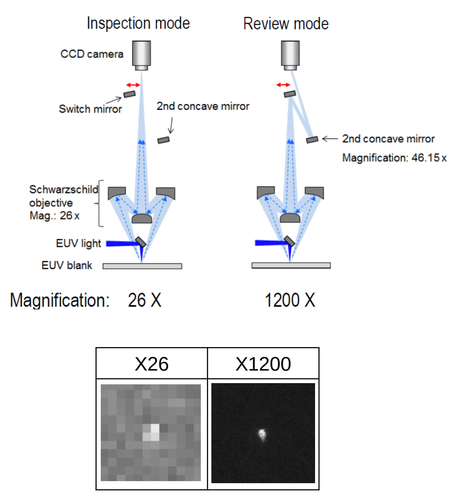
◆**There is some possibility of estimating defect size such as defect width with ABI inspection data. It is useful to have defect size information for estimating an impact on wafer pattern.**

Introduction

It is known that ABI inspection result includes some kinds of EUV blank defect information. By studying inspected data such as dark field image precisely, we can know the feature of defect. In this study, a relationship between best focus position and defect size is studied.

Motivation

It is known that defect type such as bump or pit affects focus point in ABI inspection. In this study, how does defect size affect focus position was studied with simulation and experiment. ABI image was captured with high magnification optics which was equipped to ABI tool. Figure.1 shows construction of high magnification optics and a difference between X26 optics image and X1200 optics image. By using X1200 image, accurate information can be obtained.

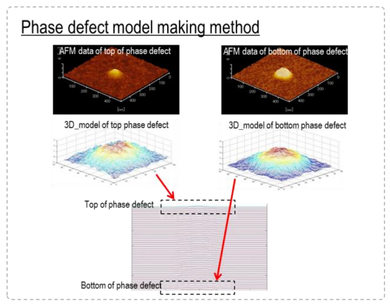


Flow of this study

Simulation-1 → Simulation-2 → Experiment

A relationship between defect size and focus position is calculated with Gaussian defect model.

3D defect model which is created directly with AFM data is used.



A relationship between defect size and focus position is checked with ABI-tool and defect sample.

- ✓ Pit defect sample
  Number of defect :15
  Size :Width(61-152nm)
  Depth(1.4-4.6nm)
- ✓ Bump defect sample
  Number of defect:9
  Size : Width(60-192nm)
  Height(1.1-3.6nm)

Relationship between defect size and focus

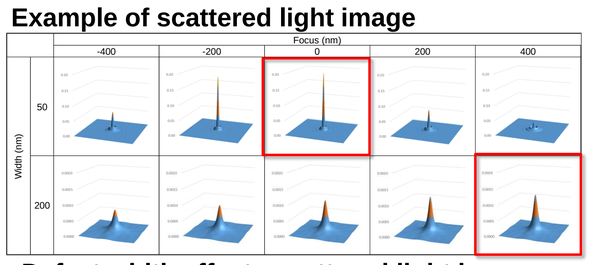
Simulation - 1

Defect width vs Focus

Simulation condition

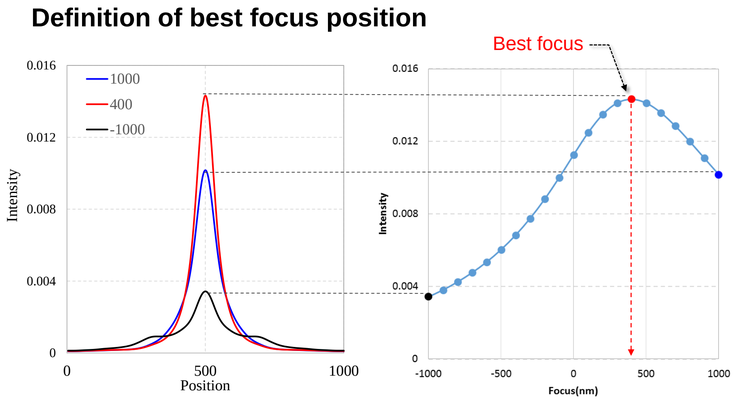
Simulator : DPS
Defect shape : Gaussain Defect width : 25-200nm
Defect height(depth) : 0.5 to 4.0 (-0.5 to -4.0)
NA : 0.1(inner)-0.27(outer) Focus variation : -1000 to 1000nm

Example of scattered light image



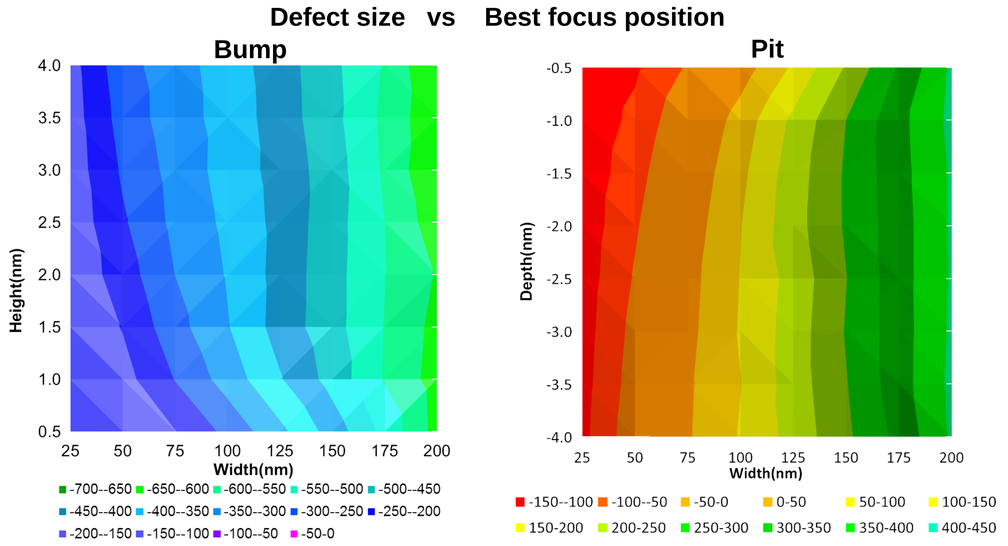
Defect width affects scattered light image.

Definition of best focus position



Focus position in which intensity shows the largest value.

Defect size vs Best focus position



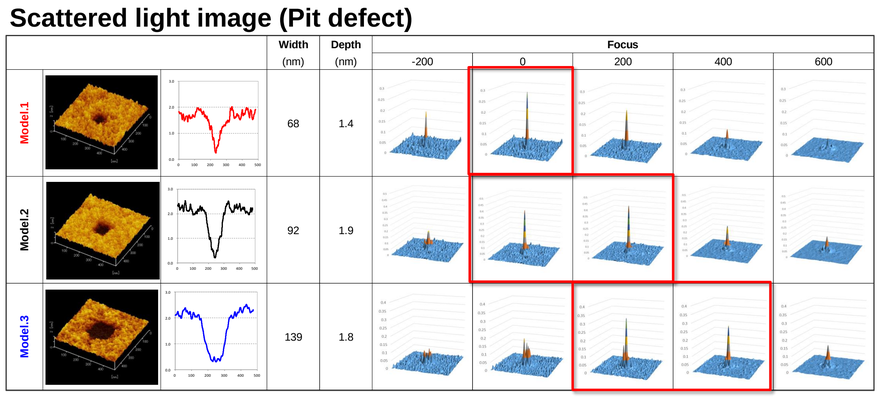
Defect width has a close relationship with focus position.
Defect height/depth affect focus position, but impact is smaller than width.

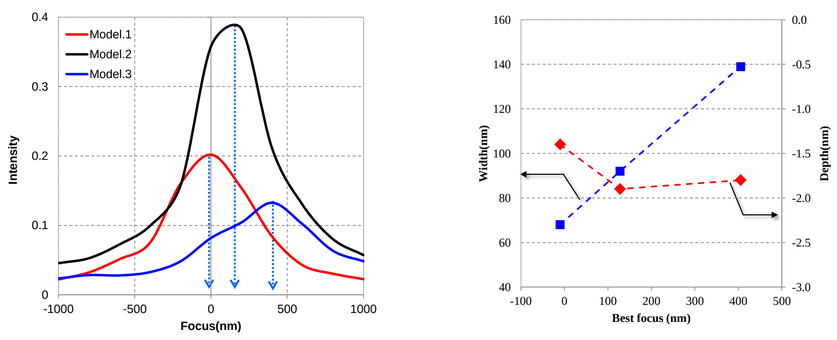
Simulation - 2

Simulation condition

Simulator : DPS
Defect shape : Created directly with AFM data
NA : 0.1(inner)-0.27(outer)
Focus variation : -1000 to 1000nm

Scattered light image (Pit defect)



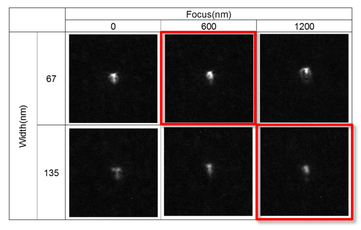


Best focus position

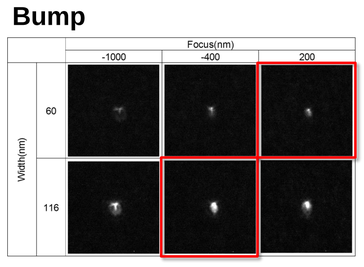
Experimental result

Example of scattered light image

Pit

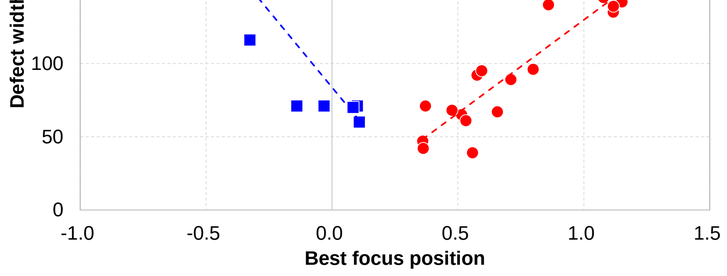


Bump

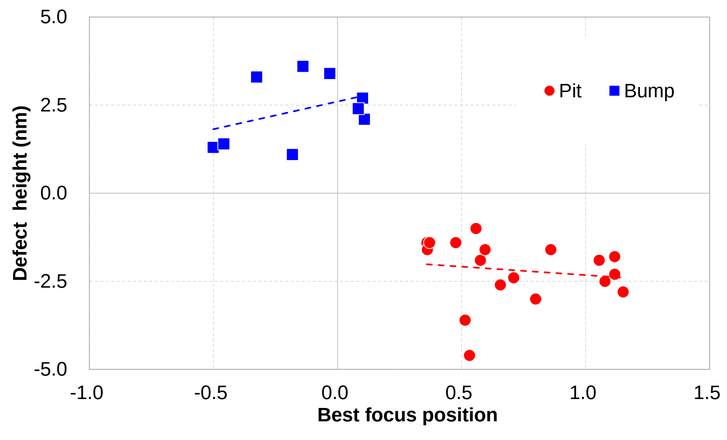


Best focus

Defect width vs best focus position



Defect height/depth vs best focus position



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